RESEARCH HIGHLIGHTS

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DAWSON CITY DEMONSTRATION MONITORING NORTHERN VENTILATION

Introduction

The approach to household ventilation in northern communities has been a subject of experimentation since at least the 1970s. Ranging from innovative approaches to passive and simple ventilation, such as proper placement of operable windows and fans, to highly sophisticated mechanical systems that combine both household heating and ventilation requirements, the North has experienced both success and failure. What has emerged is a consensus among housing professionals, particularly in the North where it is often far more difficult to find skilled tradespeople, that selected ventilation systems must be installed, operated, maintained and repaired at the local level.

Two innovative approaches to household ventilation have recently been tested in Dawson City to evaluate their performance and appropriateness in the extreme climate with limited availability of experienced, skilled tradespeople. Viewing the house as a comprehensive system, where changes in one part are considered in light of their effect on all other components of the house, both approaches attempt to integrate all of the heating and ventilation requirements into one system. One was a high-velocity fancoil unit in an integrated combination heat, ventilation and domestic hot water system; the other was based on a heat recovery ventilator incorporated into a forced air furnace heating system.

System 1: Fancoil Integrated Combination Heat, Ventilation and Domestic Hot Water System (see Figure 1)

- Space and Domestic Hot Water Heating: Space heating is provided by a fancoil unit that receives its hot water from a high-efficiency, oil-fired hot water tank. This replaces the electrical hot water tank found in many conventional hot water systems. Hot water from the hot water tank is circulated through the coil in the fancoil unit. Heat is transferred from the hot water to the air stream as air is forced over the coil, tempering both fresh air and air from the return air plenum and distributing it to the house through the supply air plenum. The single oil-fired hot water tank heats the domestic hot water and the air for space heating.
- Ventilation System: Fresh outdoor air is supplied to the return air plenum of the forced air system via an insulated, outdoor air duct. A motorized damper controls the intake of outdoor air. When the damper is open, outdoor air is drawn into the forced air system due to the suction pressure developed in the return air plenum. The outdoor air is distributed throughout the house through the space heating system.
- Combustion Air: Combustion air for the oil-fired hot water tank is supplied to the mechanical room, and is controlled by a damper that opens only on a call for heat. This prevents cold air from being delivered continuously into the house.

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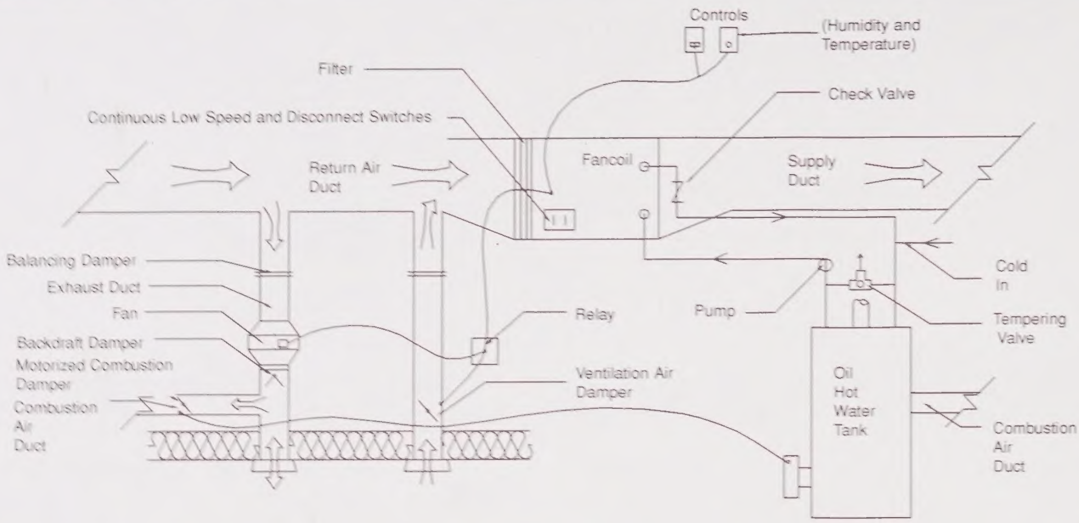
Figure 1 - High velocity fancoil integrated combination heat, ventilation and domestic hot water system



System 2: Heat Recovery Ventilation (HRV) with Forced Air Furnace (see Figure 2)

- Space and Domestic Hot Water Heating: Space heating is provided by a higher efficiency, direct vent oil-fired forced air furnace. Domestic hot water is provided by an oil-fired hot water tank, similar to that used in the fancoil integrated combination system.

- Ventilation System: Ventilation air is provided by a high efficiency heat recovery ventilator (HRV). Fresh air is drawn into the HRV unit where it is tempered by the heat in the exhaust air prior to being delivered to the furnace return air duct. It is then distributed throughout the house via the space heating ductwork.

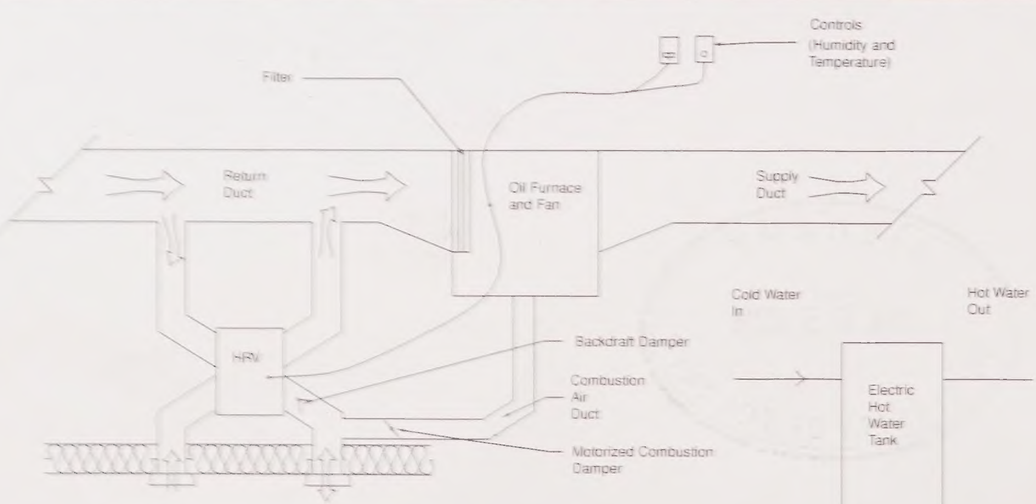
- Combustion Air: Combustion air for the furnace and hot water tank in the mechanical room is controlled by a damper that opens only on a call for heat. This prevents cold air from dumping continuously into the house, similar to the fancoil integrated combination system.

Comparing the Two Alternatives

The strengths of the fancoil integrated combination system stem from its integrated approach—space heating, domestic hot water heating and ventilation are combined into a single system:

1. Large amounts of heat can be lost when heating appliances start up and shut down repeatedly to adjust household temperatures, purging extra heat. Running one heating appliance, to meet space heating and domestic hot water needs, rather than two, reduces these stand-by losses.

Figure 2 - Heat Recovery Ventilation (HRV) with Forced Air Furnace



2. Savings are generated not only by using a more efficient system, but also by the type of energy required to operate the system. In the North, electricity is often at least three times the cost of the oil input (CMHC *Utility Costs of Northern Communities*, 2002). The elimination of an electric water tank results in significant savings.
3. Because of the limitations of furnace sizes readily available on the market, furnaces tend to be far over-sized for the amount of space they are required to heat. This is especially true for small houses. Over-sized furnaces have very short and frequent cycles, resulting in large stand-by heat losses. Fancoil integrated combination systems can be more appropriately sized and can have a modulated output, enabling them to put out only as much heat as is needed to meet demand.
4. Fancoil combination systems can be designed and installed to create a number of zones by running multiple, smaller fancoils from one hot water tank, allowing variable heating demands in the house to be met.
5. There is the potential in this type of system to temper cold, outside air before delivering it into the rooms in the house.
6. The air distribution system is very effective and inexpensive to install. Outlets can be installed at ceiling level without stratification concerns because the high velocity of the air being delivered to the space causes it to thoroughly mix with the room air.
7. With a properly sized hot water tank and the installation of controls that give hot water production priority over space heating, there is an increased availability of domestic hot water.
8. Available floor space is increased. The fancoil unit tucks into the ductwork at the ceiling level, freeing up the space otherwise required for a furnace in a traditional heating and hot water system.
9. With a single heating appliance, costs for both operation and maintenance are reduced.

While there are obviously many advantages to the fancoil integrated combination system, there are certain challenges as well. There is no capacity for heat recovery from the air being exhausted from the house. A life-cycle costing analysis would be required to determine if it would be cost-effective to incorporate a heat recovery unit into the system. As well, and more importantly, the electrical wiring required for the initial control system is complex and difficult to install and service.

While a simpler and equally effective system can be designed and installed (CMHC *Dawson City Demonstration / Monitoring Final Report*, 2002), this kind of work requires skilled labour and innovative techniques.

The advantages of incorporating a heat recovery ventilator (HRV) into a heating system arise from the system's efficiency in recovering 60 - 75 per cent of the heat from air being exhausted from the house to temper the incoming supply air. Some HRVs will recover moisture from the exhaust stream as well, helping to maintain indoor humidity in cold climates, although this feature was not present in the Dawson City system. In addition, the difficulties associated with system control found in the fancoil integrated combination system are eliminated by the household ventilation functions being controlled directly by the heat recovery ventilator. Furthermore:

1. The HRV is usually located in a closet or utility room, making for a quiet ventilation system. A properly installed HRV will not be audible in most of the house.
2. The HRV replaces several bath and utility room fans with a single system, which may run continuously or periodically, depending on which setting is chosen by the homeowner. A range hood in the kitchen may still be required.

Despite the advantage of the simpler HRV control system, this approach has its own set of challenges that arise from the household space heating, hot water heating and ventilation functions all being performed by separate systems, each requiring advanced components.

In addition to larger capital and installation costs associated with the increased number of appliances, the challenge of finding trained personnel to install complex mechanical systems in remote Northern communities is further magnified.

Properly sizing oil-fired heating appliances for low-energy homes can be a problem because oil-fired burners that provide lower heat inputs required by more efficient houses are not readily available. Therefore, since shorter heating cycles are required, the efficiency of the appliances is reduced.

As well, satisfactory air distribution can be more complex because the low velocity of a forced air heating system is not sufficient to properly mix room air in very cold weather if outlets are located at ceiling level. In order to avoid stratification, the heating outlets must be located at the floor.

Conclusion

While both of these alternatives to supplying household ventilation can be very effective, their performance is heavily influenced not only by innovative technologies, but also by understanding the technologies and developing innovative approaches to implementing them. This is particularly true in remote communities that experience unique conditions with respect to weather and the provision of goods and services. Any design involving innovative technology, especially for remote locations, must consider the trades that will be required to install and service the equipment, and the homeowner that will be operating and maintaining the system. A design that will be too difficult to install, service, operate and/or maintain is likely not an appropriate system for a particular location.

The mechanical systems should be designed as an integral part of the whole house. The designers of these systems should also be involved with their construction, commissioning and follow-up to ensure that systems are installed as intended. As with the design process, an integrated approach must be taken during construction. The builder must have sufficient expertise and experience to carry out the project goals. This will mean hiring the quality of tradesmen capable of ensuring that construction specifications and instructions are strictly adhered to. Both the fancoil integrated combination system and the HRV system are more complex than conventional heating/ventilation systems. A thorough understanding of how one part of a complex system may affect other parts of the system is imperative in order to ensure successful design.

Additional information about household ventilation systems is available from Canada Mortgage and Housing Corporation:
Non-Heat Recovery Humidity Controlled Ventilation
Fancoil Integrated Combination Heat and Domestic Hot Water Systems

These articles are posted at **www.cmhc.ca**

keyword search: *North About Your House*

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Housing Research at CMHC

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